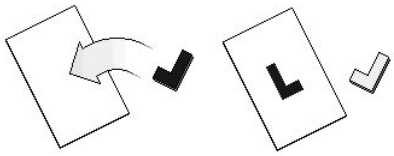
# Printers

## Technology

The original principle of printing has remained unchanged for centuries.



Ink is placed on the surface of a block. When this block is pressed against paper, much of the ink soaks into the paper and stays there when the block is removed. This principle is known as *impact* printing. Early computer printers used a form of impact printing.

However, modern computer printers use a variety of methods to transfer the ink to the page. Some spray the ink, other lay solid ink above the page and melt it into the surface. These are known as non-impact printers.

### Characters

Early printers were often restricted to a fixed set of letters of the alphabet (both upper and lower case), digits, punctuation marks and common symbols. These are collectively known as *characters*. The range of characters available to a printer is known as its *character set*.

### Dot Matrix

Subsequent printers construct text and pictures from tiny dots arranged in a *matrix*. (When people refer to a "dot matrix printer" they are usually talking about an *impact dot matrix printer*, which was the first machine to use this process.)

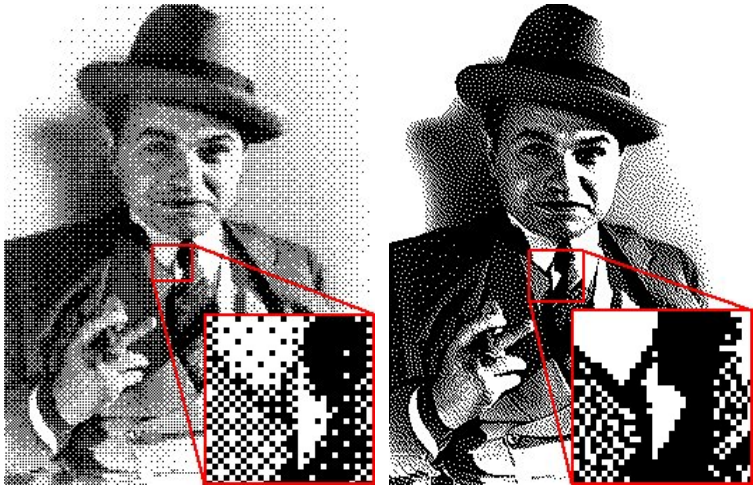
As dots get smaller, the quality of the printed image improves.
This is measured by the number of *dots per inch (dpi)*, both horizontally and vertically.

At 150 dpi the individual dots are visible to the naked eye, causing curves to appear jagged. At 300 dpi these *jaggies* are not visible. For professional printing (where fine lines and crisp text are required) 600 or 1200 dpi is recommended.

# Black & white printing

## Dithering

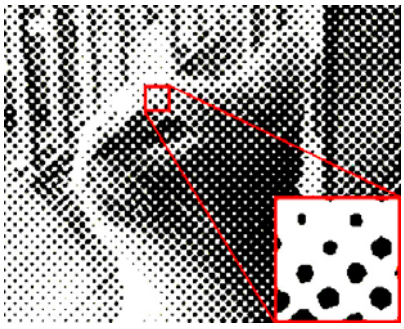
Printers cannot print grey so they use a pattern of black dots to give the impression of greyness from a distance. This process is known as *dithering*.



There are several different dithering algorithms used by printer manufacturers and some allow you to select from a range of styles.

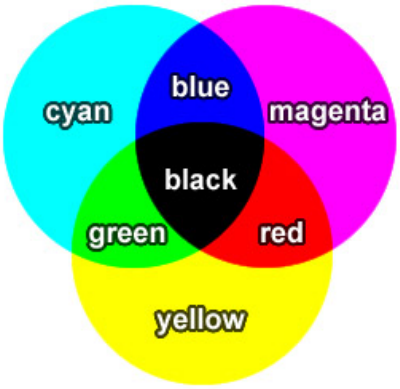
## Halftone

Very high quality printers may use *halftone patterns* to produce grey. This process has been used in newspapers, magazines and posters for many decades and uses a grid of small or large dots to produce the illusion of greyness.



# Colour

*Subtractive colour*




The colour sensors in the human eye are tuned to red, green and blue light. We can trick the brain into thinking it sees other colours by mixing differing amounts of red, green and blue light. This is called *additive colour*.

However when white light is reflected from paper, ink on the surface will filter (subtract) colours from the light. Cyan ink removes red light; magenta ink removes green light; and yellow ink removes blue light. By mixing differing amounts cyan, magenta and yellow ink on a page we can selective remove light to produce a range of colours. This is called *subtractive colour*.

*CMY (three-colour printing)*

Cheap colour printers use a mixture of cyan, magenta and yellow ink to produce coloured print on the page. Black, which is formed by mixing all three (and thus filters all red, green and blue light), is often not quite black due to variations in the hue of the three inks. Black print also suffers from thin coloured edges caused by subtle misalignment of the three inks.

*CMYK (four-colour printing)*

One of the predominant colours in printing is black and it would be wasteful to use three times as much ink when this is not strictly necessary. Therefore four-colour printing adds the *key* colour (black), separately, for increased quality and lower cost. The computer works out where black is required and tells the printer to use K instead of CMY in those places.

*Gamut problems (six- & seven-colour printing)*

The dyes used in CMY inks do not often allow vivid colours to be produced. It is possible to have a picture on screen that cannot be physically reproduced using the printer's inks in any proportions whatsoever. This is called a *gamut* problem.

Modern six- and seven-colour printers use extra dyes to cover a wider range of colours, giving more vivid results.

# Paper

## ISO sizes

A-series paper sizes are used in all countries except the US and Canada. Their chief advantage is that each size has exactly half or twice the area of the next one, which led to widespread adoption in the 1960s when photocopiers were introduced.

| | *metric* | *imperial* |
|---|---|---|
| **A0** | 840 mm × 1188 mm | 33.07" × 46.77" |
| **A1** | 594 mm × 840 mm | 23.39" × 33.07" |
| **A2** | 420 mm × 594 mm | 16.54" × 23.39" |
| **A3** | 297 mm × 420 mm | 11.69" × 16.54" |
| **A4** | 210 mm × 297 mm | 8.27" × 11.69" |
| **A5** | 149 mm × 210 mm | 5.85" × 8.27" |
| **A6** | 105 mm × 149 mm | 4.13" × 5.85" |

There is also a B-series, which has an area 50% bigger than the A-series. This is seldom used.

The C-series is used for envelopes that may contain the corresponding A-series size.
An additional envelope size, "DL", will take an A4 sheet folded into thirds.

## North American

A4 is difficult to obtain in the US because they use different paper sizes:

| | *metric* | *imperial* |
|---|---|---|
| **Quarto** | 203 mm × 254 mm | 8" × 10" |
| **Letter** | 216 mm × 279 mm | 8½" × 11" |
| **Foolscap** | 203 mm × 330 mm | 8" × 13" |
| **Legal** | 216 mm × 356 mm | 8½" × 14" |

## Quality

Paper thickness and density is quoted in grams per square metre (*gsm*). Most photocopying and computer printing paper is 80 gsm, supplied in *reams* of 500 sheets. For important letters and documents, 100 gsm or 120 gsm gives a more professional appearance.

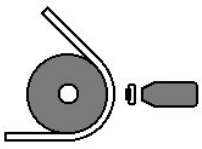
In North America thickness & density is measured in *pounds per uncut ream* (i.e. the weight in pounds of four 500-sheet reams).

The surface finish of a piece of paper will also affect the quality of printing. For a photographic effect, glossy paper is used.

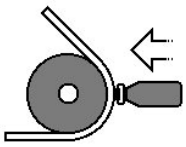
## Problems

Transparent films are used with overhead projectors (OHP). They are made of transparent plastic, often an acetate. Laser printers and photocopiers contain fuser units that may melt the plastic. The appropriate type of transparency must be used, or a costly repair may be required.

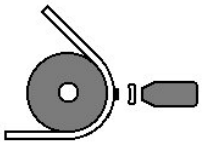
# Impact printers



Traditional printing uses shaped plates as a printing block.



Typewriters and impact printers use a ink-soaked *ribbon* instead.
The ribbon is suspended close to a piece of paper.
The paper rests on a firm surface (usually a roller) known as a *platen*.



When the metal *hammer* moves towards the paper it squashes the ribbon, transferring ink to the paper. By altering the shape of the hammer's head, different ink shapes may be left behind.

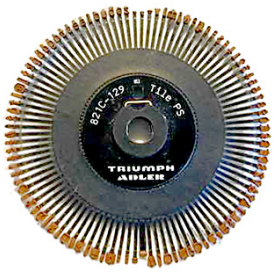
Used repeatedly, the ribbon loses more and more ink until printing becomes faint. Manufacturers make long spools of ribbon that are wound along as printing occurs, placing freshly-inked ribbon in front of the hammer. These are often encased in cartridges or cassettes.

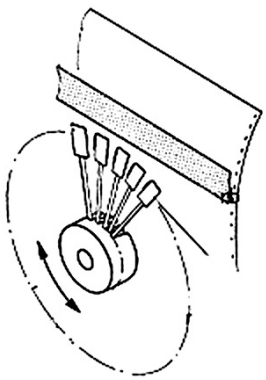
Because of the hammering action, impact printers are extremely noisy. Most impact printers print in black-and-white only.

## Character printers

### *Daisywheel printers*

These use an arrangement of shaped printing blocks on stalks — one for each character in the printer's character set. Daisywheels can be interchanged with ones featuring other alphabets or special characters. Daisywheel printers are slow but produce exceptional quality printing.



### *Golfball*

A variation on this theme, *golfball* printers, uses a rolling golfball-shaped print head with the character shapes on its surface. These were a later replacement for daisywheels on computer printers and electric typewriters.

### *Line printers*

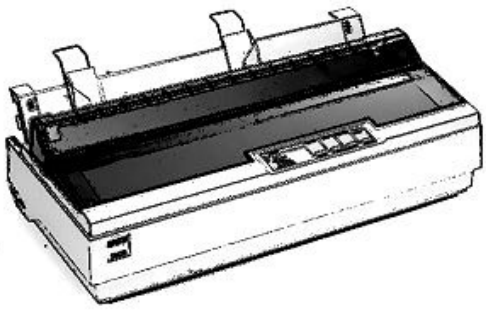
Line printers have an arrangement of print wheels to form a cylindrical print drum. A full character set is provided around the diameter of each wheel. As the drum rotates, characters can be printed at very high speed, typically 25 lines of text per second.

A variation, *drum printers*, use a drum of fixed print and timed hammers strike as the drum rotates, thus printing a line of text per revolution.

Line printers have been around since the dawn of computing and are still manufactured.

## Impact dot matrix printer

Impact dot matrix printers create a dot matrix by mounting several miniature hammers (*pins*) within a print head. By placing these pins in a near-vertical line, the head can create many dot matrices in a single printing action as it passes across the page.



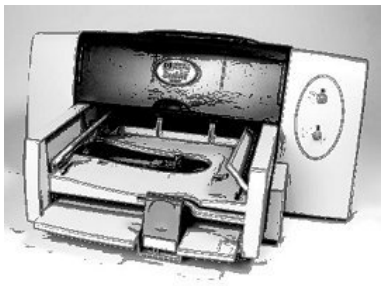
9-pin printers make large dots, typically 80 dpi. Text is poor quality but readable.

24-pin printers attain 180 dpi, giving text a quality near to that required for professional letters — Near Letter Quality (NLQ).

Impact dot matrix printers are relatively slow but are still widely used in industry. Because they press against the paper they can be used with carbon-copy or NCR (non-carbon refill) paper to produce multiple copies of invoices.

# Non-impact printers

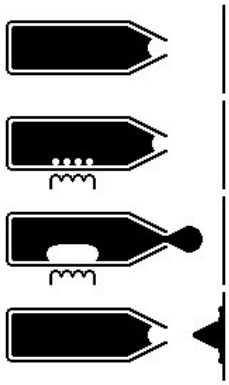
## Inkjet printer



Inkjet printers print by ejecting small dots of ink at the paper.

Most modern inkjet printers print in colour although some basic models are limited to black-and-white only. Inkjets are very cheap and quiet and an extremely popular choice for home and small offices computer systems.

Most inkjet printers are work on a *bubblejet* principle. The print head contains many tiny nozzles filled with ink. Each nozzle can be individually heated, creating an air bubble that forces a droplet of ink onto the paper.



Inkjet printers typically print at 300 dpi but they can produce output of up to 1400 dpi. They are cheap and quiet but relatively slow, typically producing 1 to 6 pages per minute (ppm).

Piezoelectric inkjet printers use piezo crystals to eject ink. These flex when electricity is applied.

Continuous flow inkjets are used for heavy industrial printing. These spray electrically-charged ink at the page by attracting it towards a high voltage.

## Plotters

### *Pen plotters*

Plotters draw shapes onto paper with pens. They are widely used in Computer Aided Design (CAD) and for engineering drawings, especially where large drawings are required. Plotters tend to be expensive and slow and need a variety of pens for colour work.

### *Inkjet Plotters*

Pen plotters are typically large, so large inkjet printers tend to be called plotters even though they do not use pens to draw pictures. These are typically used for printing one-off posters.

## Thermal printer

Many fax machines use thermal printers. They are simple and cheap to manufacture but give poor quality printing. They print by moving an electrode across the surface of some thermal paper — paper that turns black when heated.

## Laser printer

Laser printers produce high-quality print, quickly and cost-effectively.

Most are black-and-white only but specialist colour laser printers are available. They are widely found in offices, schools and colleges and work in a similar way to photocopiers.

LED printers use high-intensity LEDs instead of a laser beam.

1. *Cleaning*

   A rotating *drum* is used to carry the image that will be printed. This drum must first be cleaned by a rubber blade.

2. *Conditioning*

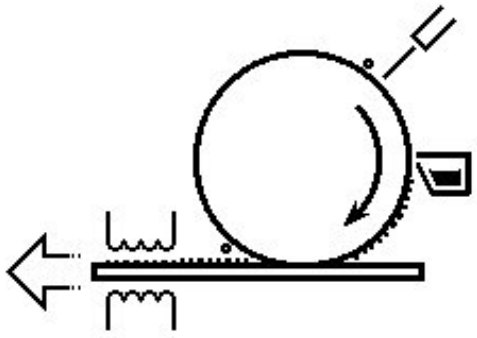
   The drum — coated with selenium, a photo-electrostatic chemical — is given a negative electrical charge by the *primary corona wire*.

3. *Writing*

   The drum is scanned by a pulsed laser beam. Where the beam hits, the surface becomes electrically charged (positive).

4. *Developing*

   The drum rotates past a dispenser containing *toner*, a fine ink powder. The toner in the dispenser is also electrically charged (negative). It is attracted to the areas of the drum that have a positive charge. As the drum rotates a fine layer of toner is deposited on the drum.



5. *Transferring*

   The rotating drum then contacts the paper, which is supported by *rollers*. The *transfer corona wire* charges the paper with a greater positive charge, attracting the toner to the paper.

6. *Fusing*

   The paper is finally fed through a fuser, a heater (350 ºF ) that melts the toner into the paper, forming a permanent bond. Without the fuser the print could be literally blown off the page.

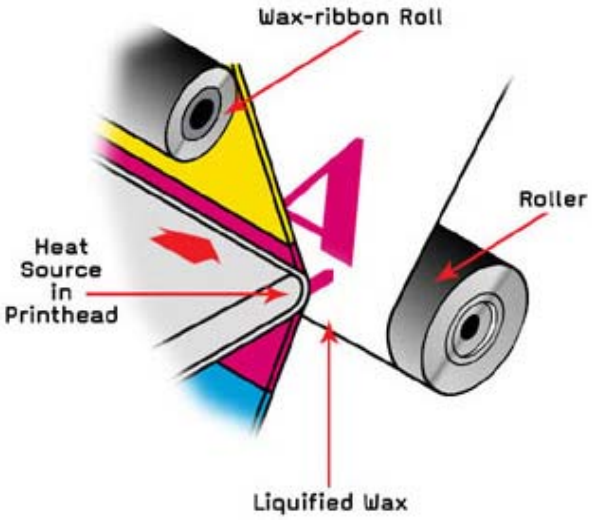
*Common problems*

- The ozone filter should be replaced during maintenance.
- The transfer corona can cause the print to be too light.

## Solid ink (Thermal transfer)

Solid ink printers melt coloured wax bars (or wax ribbon rolls) onto the paper, using small heated print heads to form a dot matrix pattern (around 300 dpi).

The thick print layer is resistant to water, sunlight and is ideally suited for labels and barcodes and for printing onto fabrics and plastics.  It also produces good quality photographic prints.




## Dye sublimation

This type of printer uses heat to transfer dye onto a medium such as a plastic card, printer paper or poster paper.  One colour is laid at a time using a panelled colour ribbon, usually CMYK.  Most dye-sublimation printers are used for producing photographic prints.

Printouts have a good shelf life and do not fade like inkjet prints.  They are also waterproof.